Coexistence of 5G User Equipment and Fixed Links in the 71-76 GHz & 81-86 GHz Bands

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Abbreviations

3GPP	The 3rd Generation Partnership Project
5G	5th generation mobile networks or 5th generation wireless systems
AP	Access Point
EIRP	Equivalent Isotropically Radiated Power
F/B	Front-to-Back Ratio
FCC	Federal Communications Commission
FL	Fixed Link
I/N	Interference-to-Noise Power Ratio
ITU	International Telecommunication Union
LoS	Line of Sight
LTE	Long-Term Evolution
MIMO	Multiple Input Multiple Output
mmW	Millimeter Wave
NF	Noise Figure
NLoS	Non Line of Sight
NPRM	Notice of Proposed Rule Making
Rx	Receiver
Tx	Transmitter
UE	User Equipment
UMa	Urban Macro-Cell

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1. Introduction

This Appendix discusses the coexistence of existing fixed microwave systems and mobile 5G User Equipment (UE) in 70 GHz and 80 GHz bands. This study completes the previous one on coexistence between 5G Access Points (APs) and fixed microwave systems in 70/80GHz submitted by Nokia in its

comments to the FNPRM.[1]The analysis framework and methodology are also detailed in Nokia's comments and are not reproduced here.

2. Analysis of Interference

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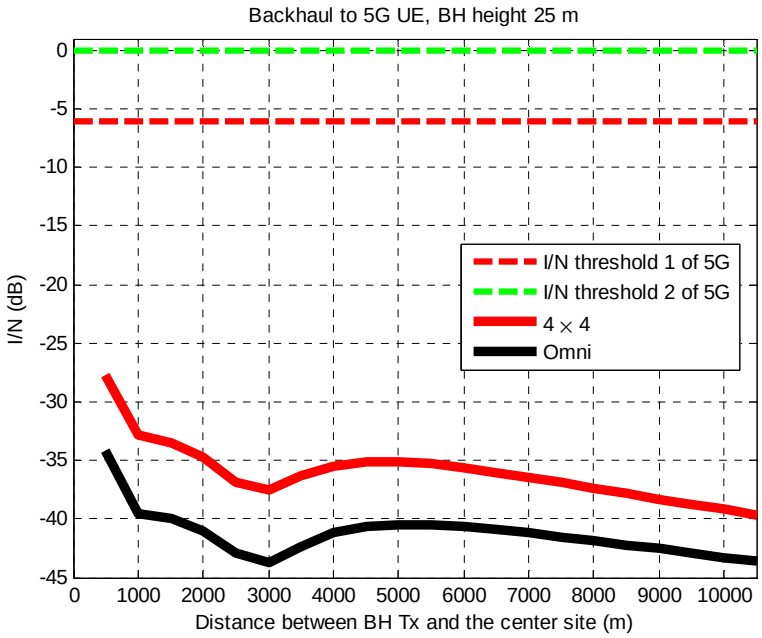
Figures 1 and 2 show the simulation results for the two resulting scenarios:

1. Fixed link to 5G UEs
2. 5G UEs to Fixed link

Similar to the case of coexistence between Fixed links and 5G APs, interference that 5G UEs causes into a Fixed link system is higher than the one in the other direction. The reason is that the interference is *aggregated* over the UEs distributed in the 57 cells/sectors. On the other hand, in a Fixed link-to-5G interference scenario, the interference from one Fixed link Tx is seen at 57 Rx cells/sectors in the 5G system, which results in an *average* over the UEs distributed in each of the 57 sectors.



[1] See Comments of Nokia, GN Dkt Nos. 14 177, et al. (filed Sept. 30, 2016) at Appendix 1.

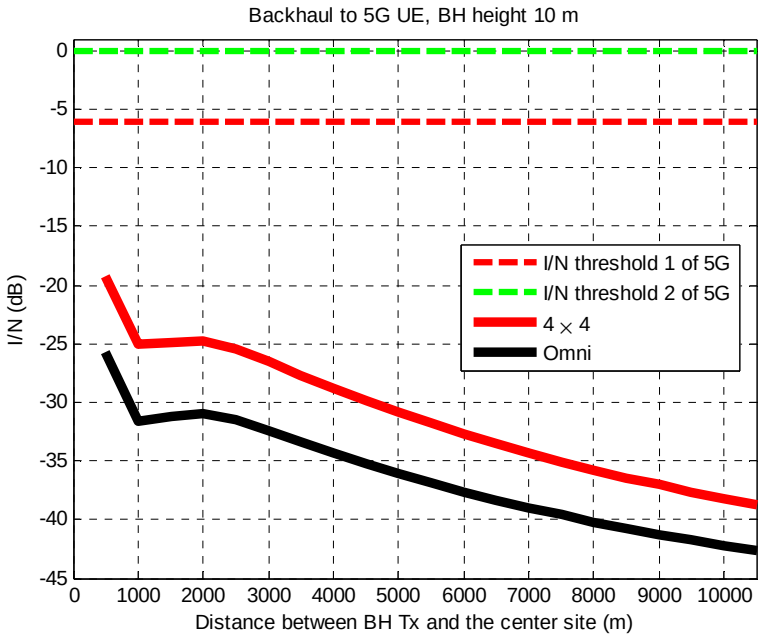
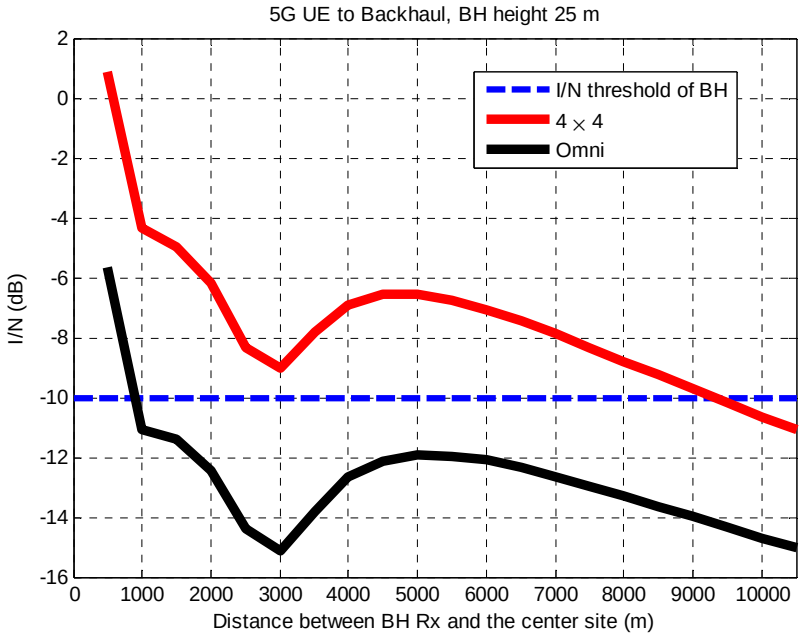


Figure 1. Interference from Fixed link into 5G UE



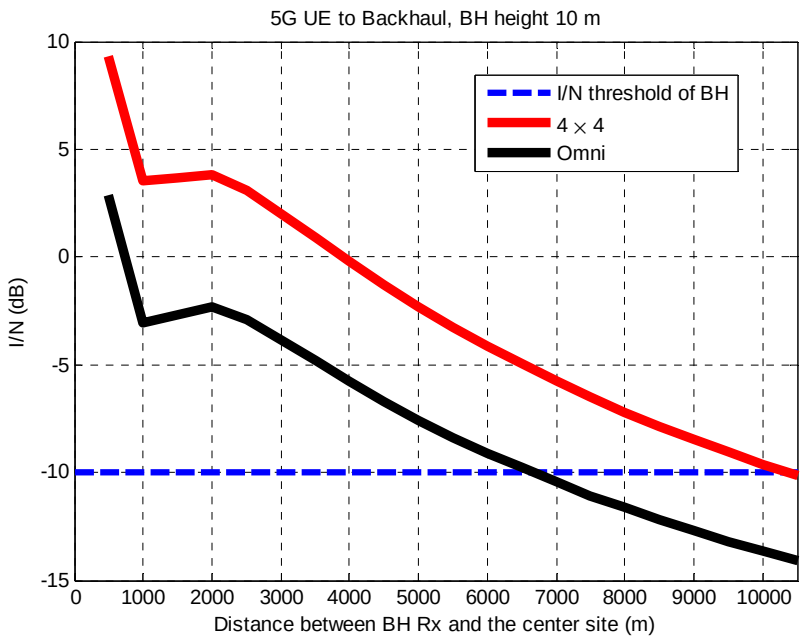


Figure 2. Interference from 5G UE into Fixed link

3. Mitigation of 5G UE-to-Fixed Link Interference

As observed in Figures 1 and 2, 5G UEs have the potential of causing interference into the Fixed link system under certain assumptions. This could lead to the requirement of a separation distance of a few kilometers between the two systems as illustrated in Figure 2.

We hereby propose a method of (i) identifying UEs that cause high interference level into Fixed link Rx's and (ii) suppressing that interference. In step (i), *a UE embeds a special cell-specific pseudo-random signal (a PN sequence) into the UE uplink Demodulation Reference Signal (DMRS) pilot sequences* that would uniquely identify the serving cell of the transmitting UEs. Based on the time-slot (or subframe) of the interfering transmission and the identity of the serving cell, an interfering UE can be uniquely identified in the 5G access system.

In step (ii), *the interfering UEs are handed over to alternative APs* toward which the UEs can point the uplink beams with interference powers that are below the interference threshold of the Fixed link. When no alternative AP exists within an interfering UE’s range, the UE shuts down its uplink transmission for the specific time slot.

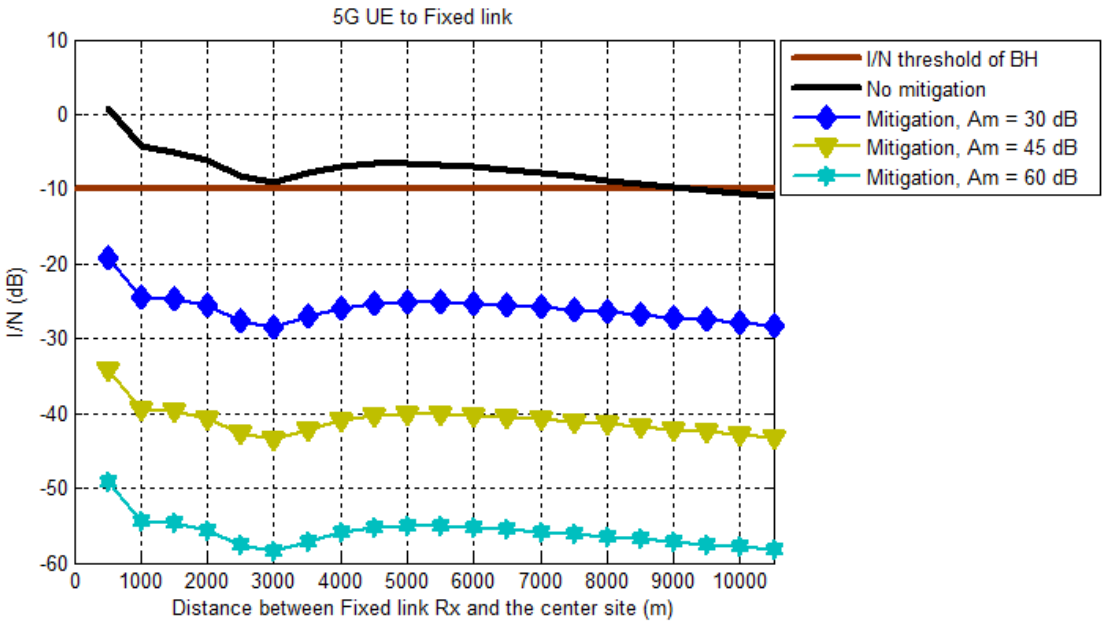


Figure 4. Impact of UE interference mitigation on interference into Fixed link

Figures 4 demonstrates the impact of the UE mitigation technique on UE-to-Fixed link interference. The figure shows I/N measured at the Fixed link Rx with different values of the maximum attenuation (front-to-back ratio), A_m. It can be obviously observed that higher A_m results in higher interference suppression.

4. Conclusion

Our simulation results showed that UE interference into Fixed link could be more significant than the other way around. An effective technique for mitigation of interference from the 5G UE to the Fixed link in the 70 GHz Band (71-76 GHz) was also discussed in this Appendix.